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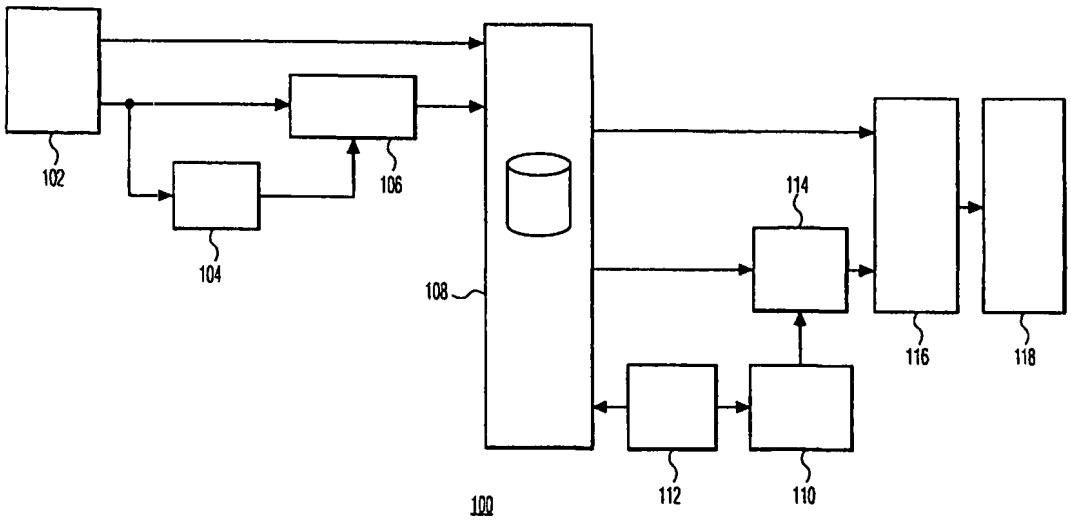
(54) Title: SCALABLE SYSTEM FOR VIDEO-ON-DEMAND



(57) Abstract: A VOD service is emulated in an NVOD architecture. Content information is made available to an end-user in the NVOD architecture. An introductory portion of the content information is stored at the end-user's equipment, e.g., by downloading overnight. During playing out of the introductory portion at the end-user enabling the content information supplied in the NVOD architecture is buffered at the end-user's equipment. The equipment is controlled to switch from playing out the introductory portion stored to playing out the buffered content information.

WO 01/24526 A1

Scalable system for video-on-demand.

FIELD OF THE INVENTION

The invention relates in particular to a system and method to implement a video-on-demand (VOD) service using any transmission network such as cable TV and the Internet.

BACKGROUND ART

A VOD delivery system is a system for giving program information through bidirectional transmission paths between a supply center and subscribers. In a wider sense, the VOD delivery system handles multimedia information including still images, high-quality television images, computer software, etc. However, the term "VOD delivery system" is often used in a narrower sense as a system for handling movies, television programs, etc. Typically, therefore, the term Video-on-demand (VOD) refers to a service that enables subscribers to select videos from a central server for viewing on a television or the display monitor of a PC. Owing to the large amounts of data required by video, VOD via a data network such as the Internet, does not scale to a large number of users. VOD requires huge network bandwidth and huge servers. Near-VOD (NVOD) is a solution to the scalability problem of VOD. But users do not get true control over the video: they neither control the starting time, nor can they pause the program or rewind the video. In NVOD programming, the interactive entertainment system broadcasts several time-shifted versions of an interactive application (i.e., broadcasts duplicate versions of the application, with the starting time of each version offset by a unique, predetermined time increment) to all of its subscribers over shared communication paths. Typically, interactive systems utilize NVOD services to provide several presentations of a movie, where the presentation start-times are staggered so that no two presentations start at the same time.

Published European Patent Application EP 0 749 242 A1 describes a VOD system that has a server which operates in the near-video-on-demand (NVOD) mode. The server transmits multiple copies of each program via multiple, separate transmission NVOD channels. The transmission of a specific program via one NVOD channel is offset in time by a fixed time interval relative to transmission of the same program via another NVOD channel.

As a result, different NVOD channels show different stages of evolution of the same program. Upon a request from a client for receipt of a particular program, the server sends to the requesting client the beginning portion of the program via a VOD channel that is not an NVOD channel. The beginning portion provided has a duration equal to or shorter than the stagger time interval. The client is controlled to start recording the program in progress on a specific one of the NVOD channels. The specific NVOD channel is the one on which the transmission of the program started the shortest time period ago relative to the request. This ensures an overlap in information content, from a certain moment on, between the recording and the play-out of the beginning portion. The overlap enables an, in principle, seamless transition in switching from the VOD channel to the specific NVOD channel.

A disadvantage of the known system is that it is not scalable to the number of users. Each request for a beginning portion needs a separate VOD channel to the end user, on top of the number of NVOD channels to implement the NVOD mode.

SUMMARY OF THE INVENTION

An object of the invention is to provide a novel method of emulating a VOD service in an NVOD architecture. Another object is to provide a method that allows for scalability. In the method of the invention content information is being made available to an end-user in the NVOD architecture. An introductory portion of the content information is enabled to be stored at the end-user's equipment. During play-out of the introductory portion at the end-user the content information supplied via the NVOD architecture is enabled to be buffered at the equipment. The method further enables to switch from playing out the stored introductory portion to playing out the buffered content information. In a more specific embodiment, the content information comprises multiple programs, and the introductory portion comprises respective ones of multiple introductory parts associated with respective ones of the multiple programs. The switching now comprises shifting from playing out a specific introductory part to playing out a specific program associated with the specific introductory part.

The inventor proposes to store at the user's client the beginning portions of all different programs available in the NVOD mode. The user can thus surf the channels at his/her own storage device, that preferably comprises a hard disk, and select a program based on the stored portions. Once a portion is selected and is being played out, recording is started of the relevant NVOD channel nearest in time for that particular program. The local storage of the introductory portions makes the system scalable. The introductory portions could be stored,

e.g., overnight while recording from a certain TV channel, or could be downloaded via a data network, e.g., the Internet, or could be provided stored on a physical device, e.g., a DVD or a card with a solid state semiconductor memory, e.g., a flash memory card.

Streaming of video over IP networks requires some buffering of the data. This buffering is required to minimize the adverse effects of the low quality of service of IP networks. This delays start-up time. The invention leverages local mass storage capability, e.g., on a set top box (STB) and uses a NVOD service to emulate a VOD service. Data broadcasting stores the beginning of all movies in a collection on the local mass storage device of the set top box. When the user chooses to watch a specific movie, the STB starts playing the movie from the local storage. In parallel, the STB tunes to the proper NVOD channel and starts buffering the rest of the movie. The portion of the movie stored locally needs not be longer in duration than the staggering interval of the NVOD service. The STB can provide an instantaneous start of the movie play back. Since the STB buffers the video stream, the user can pause and rewind the movie as if he/she was controlling a VCR. Of course, fast-forwarding past the current buffer content is not possible. If the buffer is a recirculating buffer, i.e., the stored content is overwritten by new content each time the buffer is full, a fast rewind past the overwritten content is not possible either.

User profiling and personalization can be used to automate the selection process of which movies to store on the local mass storage device.

The apparatus of the user's equipment storing the introductory portion may, but need not, be the same apparatus as the one buffering the content information supplied via the NVOD. If these are two separate apparatuses, it is required that they cooperate to minimize the perceivable effect in terms of an interruption when switching from the one to the other for playing out. If they are one and the same storage device, it is required that it allows read and write operations at the same time.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is explained by way of example and with reference to the accompanying drawings, wherein:

Fig.1 is a block diagram of an NVOD server system in the invention;

Figs.2 and 3 are block diagrams of a client for connection to the system of Fig.1; and

Fig.4 is a block diagram of some details of the client.

Throughout the figures, same reference numerals indicate similar or corresponding features.

PREFERRED EMBODIMENTS

First, an environment for analog video is discussed in detail. Then a system for digital video is discussed.

Fig.1 is a block diagram of an NVOD server system 100 for delivery of analog video and audio. System 100 comprises an analog Audio/Video (A/V) source 102, e.g., a video tape recorder (VTR), a frame counter 104, a data insertion sub-system 106 and a storage sub-system 108. A/V source 102 supplies analog A/V program content. Counter 104 counts the frames in the introductory portion of the A/V content, and sub-system 106 adds the frame number as data to the VBI (vertical blanking interval) after the associated frame. Alternatively, a flag is inserted in the VBI only after the last frame, or one of the last frames of the beginning portion of the A/V program content. The flag then indicates that the switching should occur. Having a flag after a frame preceding the last frame is advantageous, for example, to take into account the latency in the control process of the switching. The A/V content including the labeled frames of the introductory portion of each A/V program is then stored in storage system 108. System 100 further comprises a program information generator 110, a download scheduler 112, a sub-system 114 for data insertion in the VBI, and an interface 116 to a delivery network 118. Generator 110 generates program information under control of download scheduler 112. The program information includes the number of frames in the introductory portion, i.e., the number of labeled frames and, for example, the title of the program, the name of the content owner and the name of the author. Scheduler 112 determines how frequent and when the introductory portion of each program is being made available to delivery network 118 for being stored at the client (not shown here), e.g., each night from 3am to 4am. Sub-system 114 inserts the information generated in generator 110 into the VBI at the beginning of the introductory portion of each program to be downloaded to the client via network 118.

Fig.2 is a block diagram of a client 200 for receipt of the introductory portions of the A/V content programs as downloaded from system 100 for local storage. Client 200 comprises an interface 202, a VBI parser 204, a memory 206, A/D converters 208 and 210, MPEG encoders 212 and 214, a multiplexer 216 and a memory 218.

Interface 202 couples client 200 to delivery network 118 and supplies an audio path and a video path. Parser 204 is connected to the video path and parses the VBI

information. Parser 204 extracts the program information, such as the program's title, the names of the content owner and of the author, etc., as generated by generator 110. Parser 204 further extracts the number of labeled video frames of the introductory portion of the program, and the frame number currently received. The program information and the total number of the frame label is stored in a data base in memory 206. A/D converter 208 converts the analog video signal received over network 118 into a digital video signal. The digital video signal is suppled to MPEG 212 encoder for compressing the digital video signal. A/D converter 210 encodes the analog audio signal received over network 118 into a digital audio signal. The digital audio signal is compressed by MPEG encoder 214. The digital compressed audio and video signals are then stored in memory 218 via multiplexer 216.

Fig. 3 is a block diagram of client 200 of Fig.2 showing components for playing out the content. In addition to the components introduced in Fig.2, client 200 comprises a buffer 302, a switch 304 with an output 306, a controller 308 and a frame counter 310. When the user starts playing out the introductory part of a specific A/V content program that is stored in local storage 218, switch 304 is the position wherein output 306 is connected to storage 218. Counter 310 keeps track of the frames supplied by storage 218. Controller 308 receives a signal representative of the number of frames supplied by storage 218. Controller also receives from data base 206 the total number of frames comprised in the introductory part stored. Controller 308 compares the frame number received from counter 310 with the total number of frames as stored for this introductory part. If the controller determines that the numbers are equal switch 304 is controlled so as to connect to buffer 302.

Buffer 302 receives the digitized compressed content as supplied by system 100 in the NVOD mode and is received at client 200 via A/D converters 208 and 210 and encoders 212 and 214. The size of buffer 302 is determined by the stagger time interval of the NVOD that in turn determines the length needed for the introductory portion. When the user starts playing out the introductory portion of a program from local storage 218, system 100 selects among the NVOD programs on delivery network 218 that specific channel that started supplying the same program the shortest time ago. Such information for controlling that selection is, for example, available from data base 206. Assume that the last frame of the introductory portion is being supplied from local storage 218. The same frame is now available somewhere in buffer 302 because an overlap in content is required. All frames of the introductory portion have been tagged or labeled. Controller 308 therefore controls buffer 302 to start supplying the frame after the last tagged one.

Fig. 4 shows switch 304 in more detail. Switch 304 comprises demultiplexers 402 and 404, audio decompressors 406 and 408, an audio mixer 410, a D/A converter 412, a video path switch 414, a decoder 416 and a D/A converter 418. Demultiplexer 402 is connected to input A of switch 304 and demultiplexer 404 is connected to input B of switch 304 (see Fig.3). Demultiplexers 402 and 404 each generate a video stream and an audio stream.

The audio stream from demultiplexer 402 is supplied to a decompressor 406. The audio stream from demultiplexer 404 is supplied to a decompressor 408. The outputs of decompressors 406 and 408 are connected to data inputs of mixer 410. Mixer 410 is controlled by controller 308. The output of mixer 410 is connected to D/A converter 412 that supplies analog audio output. Mixer 410 is controlled to produce a glitch-free audio signal by, for example, phasing in the signal received from buffer 302 and phase out the audio signal from local storage 218.

The video stream is switched in switch 414 between two frames from input A to input B. Switch 414 is also controlled by controller 308. This produces a continuous bitstream of digital video that is decoded in decoder 416, and then converted to analog in D/A converter 418 for analog play-out. Preferably, the video encoding is such that the last frame is not a B-frame (bi-directional frame). That is, the decoding of the last frame of the introductory portion does not require a subsequent frame. Also, the encoding is preferably such that the first frame supplied by buffer 302 is an I-frame (intra frame), whose decoding does not require a previous frame. These restrictions ensure that the output of switch 414 is a continuous video stream.

The above example relates to analog content. The case of digital content is relatively simple. Digital video bitstreams have time stamps. They can therefore be cut at any frame transition and re-spliced using the proper time stamps as a reference in order to recreate exactly the same bitstream. In order to implement the VOD concept the time stamp of the end of the introductory portion of the program needs to be communicated to the client in the download phase. To splice the program content the client compares the stored time stamp (that indicates the end of the introductory portion) to the current time stamp of the bitstream being played out from the local storage. When the comparison signals that the time stamps are equal, the client switches the video source from local storage to the buffer. The configuration of the system for digital content is, for example, functionally similar to that of the analog case discussed above, but does not comprise A/D and D/A converters 208, 210, 412, and 418, does not comprise compressors 212 and 214 and decompressors 406 and 408, does not comprise the components for processing the frame numbers, and it does not need audio mixer 410 either.

Within the context of the curent invention, the following patent documents are incorporated herein by reference:

- U.S. Serial No. 09/283,545 (attorney docket PHA 23,633) filed 4/1/99 for Yevgeniy Eugene Shteyn for TIME- AND LOCATION- DRIVEN PERSONALIZED TV. This document relates to a server system that enables a subscriber to select a specific broadcast program for recording and a specific location and time frame for play-out of the recorded program.

- U.S. Serial No. 09/149,950 (attorney docket PHA 23,495) filed 9/9/98 for Raoul Mallart for REAL-TIME VIDEO GAME USES EMULATION OF STREAMING OVER THE INTERNET IN A BROADCAST EVENT. In a broadcast application on a client-server network the streaming is emulated of animation data over the Internet to a large number of clients. The animation is considered a sequence of states. State information is sent to the clients instead of the graphics data itself. The clients generate the animation data itself under control of the state information. The server and clients communicate using a shared object protocol. Thus, streaming is accomplished as well as a broadcast without running into severe network bandwidth problems. This is approach is used to map a real life event, e.g., a motor race, onto a virtual environment in order to let the user participate in a virtual race against the real life professionals, the dynamics of the virtual environment being determined by the state changes sent to the user.

- U.S. Serial No. 09/138,782 (attorney docket PHA 23,491) filed 8/24/98 for Raoul Mallart and Atul Sinha for EMULATION OF STREAMING OVER THE INTERNET IN A BROADCAST APPLICATION. This document relates to a broadcast application on a client-server network wherein the streaming is emulated of animation data over the Internet to a large number of clients. The animation is considered a sequence of states. State information is sent to the clients instead of the graphics data itself. The clients generate the animation data itself under control of the state information. The server and clients communicate using a shared object protocol. Thus, streaming is accomplished as well as a broadcast without running into severe network bandwidth problems.

- U.S. Serial No. 09/053,448 (attorney docket PHA 23,383) filed 4/1/98 for Raoul Mallart and Atul Sinha for GROUP-WISE VIDEO CONFERENCING USES 3D-GRAPHICS MODEL OF BROADCAST EVENT. This document relates to a TV broadcast service to multiple geographically distributed end- users that is integrated with a conferencing mode. Upon a certain event in the broadcast, specific groups of end users are switched to a conference mode under software control so that the group is enabled to discuss the event. The conference mode is enhanced by a 3D graphics model of the video representation of the event that is

downloaded to the groups. The end users are capable of interacting with the model to discuss alternatives to the event.

CLAIMS:

1. A method of emulating a VOD service in an NVOD architecture (108), the method comprising:

- making content information available to an end-user (200) in the NVOD architecture;
- enabling to store (218) an introductory portion of the content information at the end-user's equipment ;
- during playing out of the introductory portion at the end-user enabling to buffer (302) the content information supplied in the NVOD architecture at the end-user's equipment;
- enabling to switch (304) from playing out the stored introductory portion to playing out the buffered content information.

2. The method of claim 1, wherein:

- the content information comprises multiple programs;
- the introductory portion comprises respective ones of multiple introductory parts associated with respective ones of the multiple programs; and
- the enabling to switch comprises enabling to shift from playing out a specific one of the introductory parts to playing out a specific one of the multiple programs associated with the specific introductory part.

3. The method of claim 1, wherein:

- the content information is broadcast via a data network (118) ;
- the introductory portion is supplied via the data network.

4. The method of claim 1, wherein:

- the content information is broadcast via a TV network; and
- the introductory portion is supplied via the TV network.

5. The method of claim 1, wherein:

- the content information is broadcast via a TV network; and
- the introductory portion is supplied via a data network.

6. The method of claim 1, wherein the introductory portion is provided to the end-user stored on a physical device.

7. The method of claim 2, wherein:
- the content information comprises frames in an analog format ;
- the enabling to switch comprises labeling (104/106) successive ones of the frames of the introductory portion in a VBI signal; and
- the switching is controlled by the labeling.

8. The method of claim 2, wherein:
- the content information comprises frames in a digital format with time stamps; and
- the switching is controlled by the time stamps.

9. A client apparatus (200) for use in a client-server system that emulates a VOD service in an NVOD architecture, wherein:
- the system has a server (108) that makes content information available to the client in an NVOD mode;
- the client has a storage (218) for storing an introductory portion of the content information;
- the client has a buffer (302) for buffering the content information supplied in the NVOD mode during playing out of the introductory portion; and
- the client has a switch (304) to control switching from playing out the introductory portion from the storage to playing out the content information from the buffer.

10. The client apparatus of claim 9, wherein:
- the server makes available the content information in an analog format;
- the introductory portion has frames with labels;
- the client has a parser (204) to extract information about the labels; and
- the client has a controller (308) to control the switching under control of the information.

11. The client apparatus of claim 9, wherein:
- the server makes available the content information in a digital format with time stamps; and
- the client has a controller to control the switching under control of the time stamps.

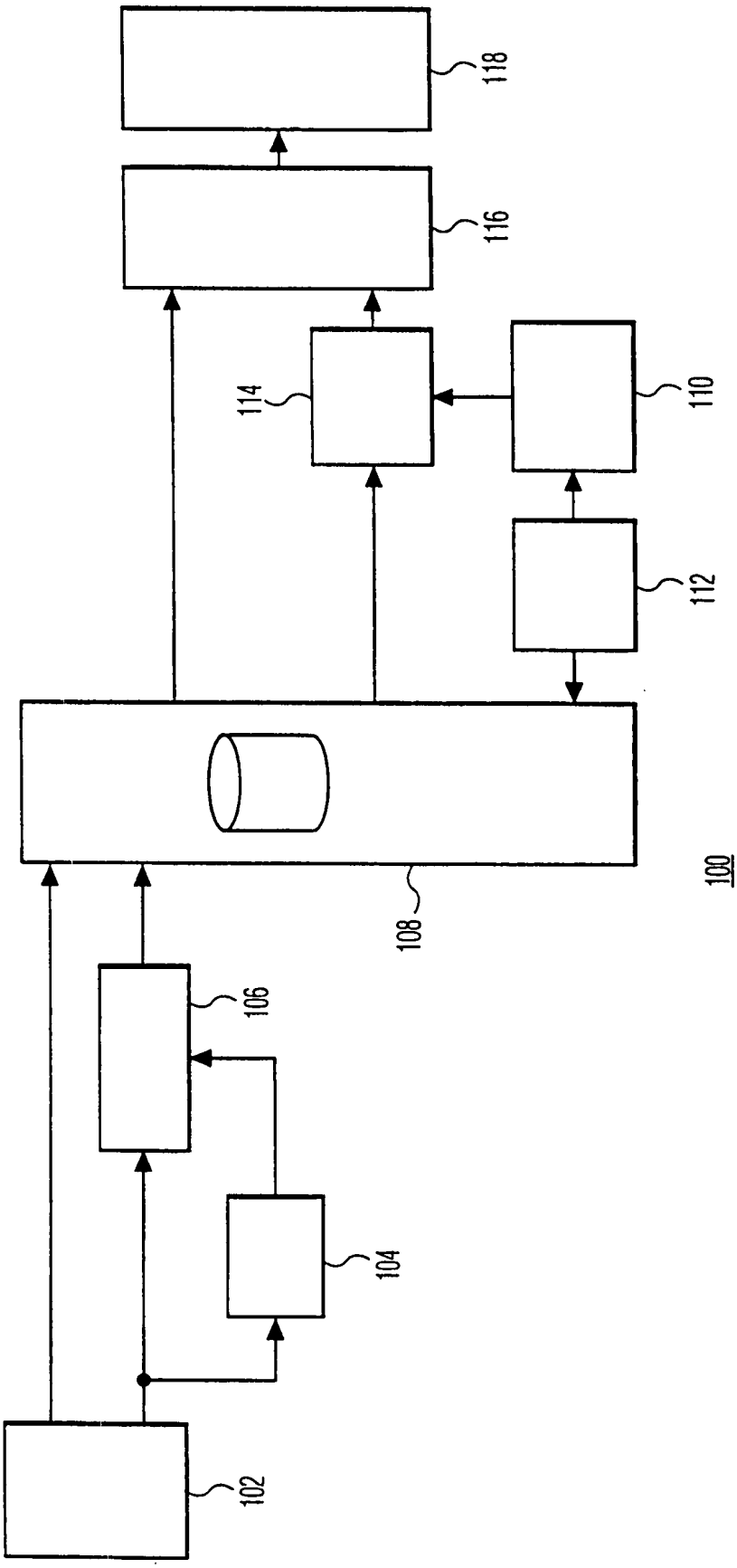


FIG. 1

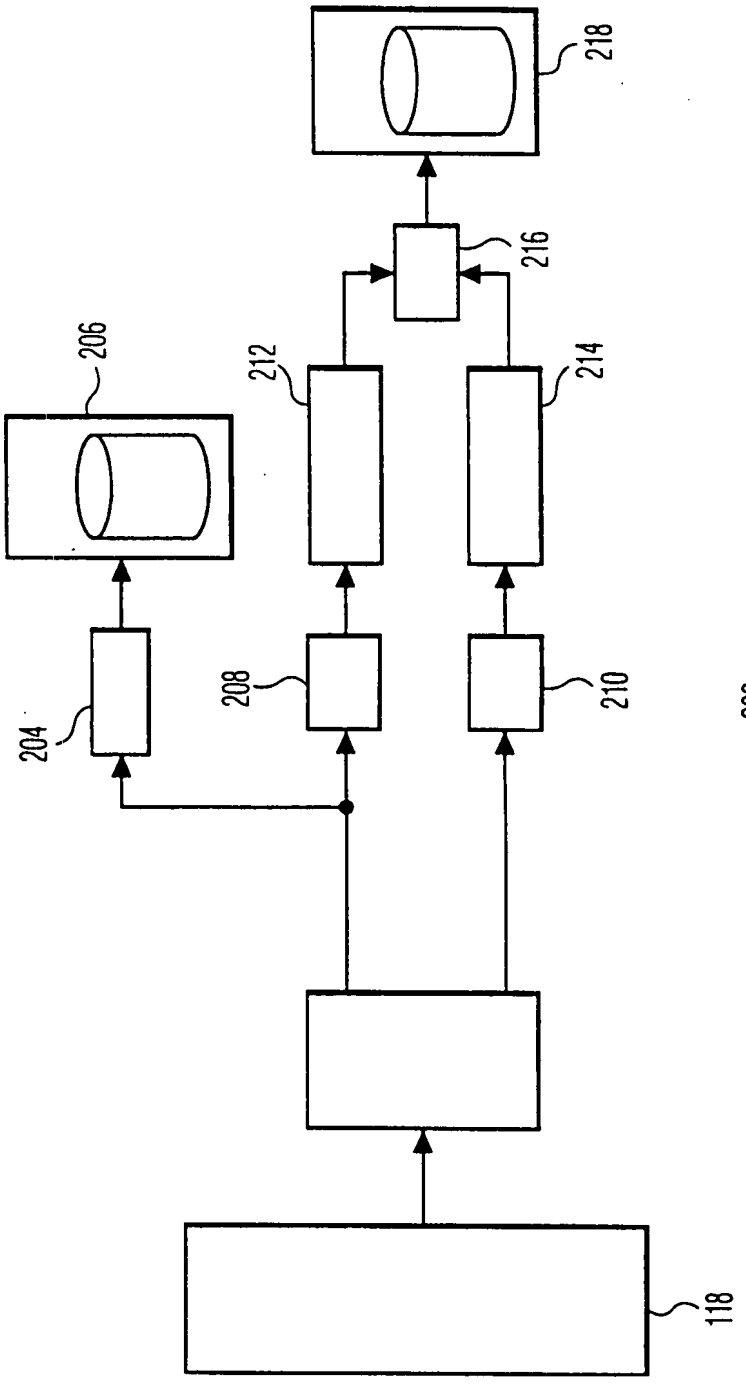


FIG. 2

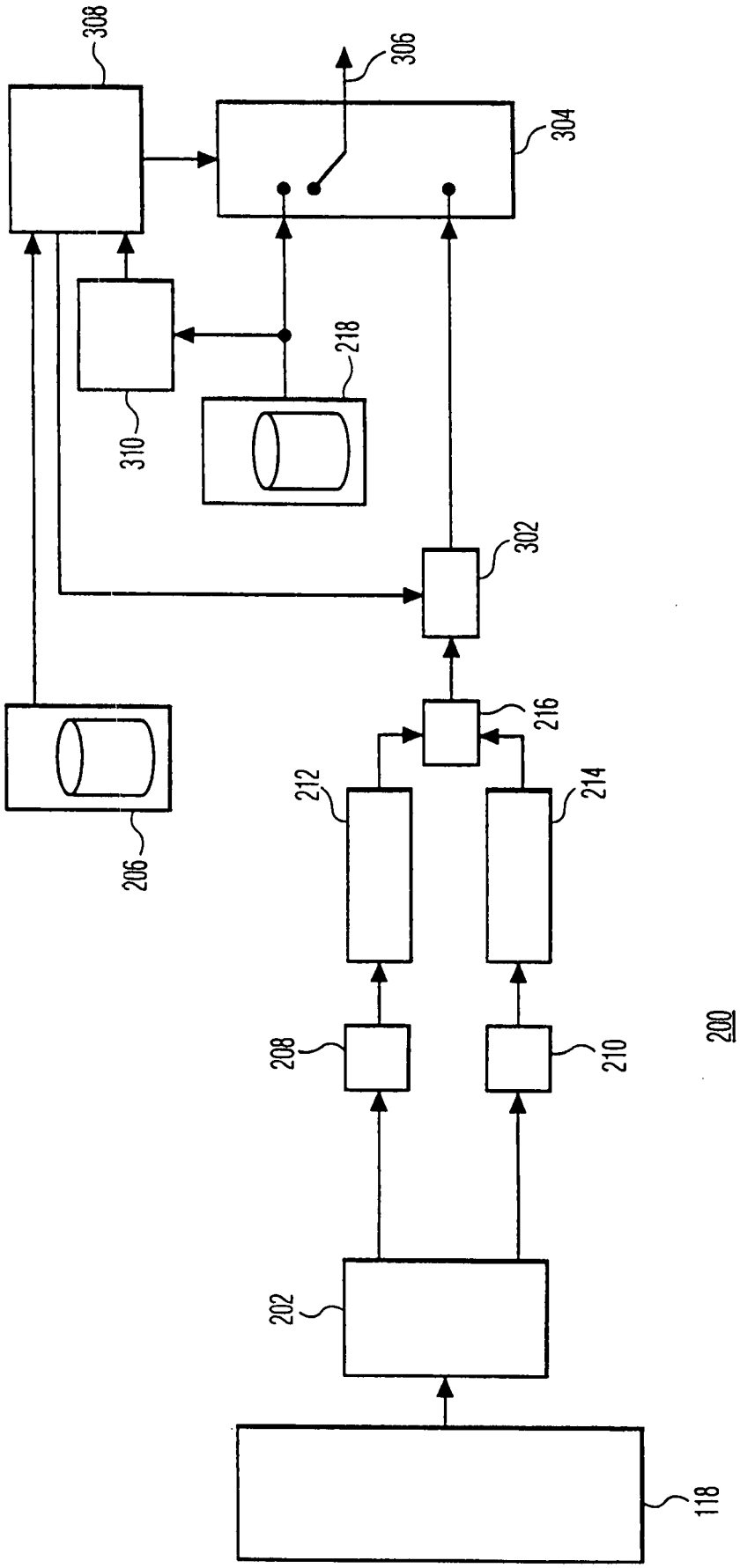


FIG. 3

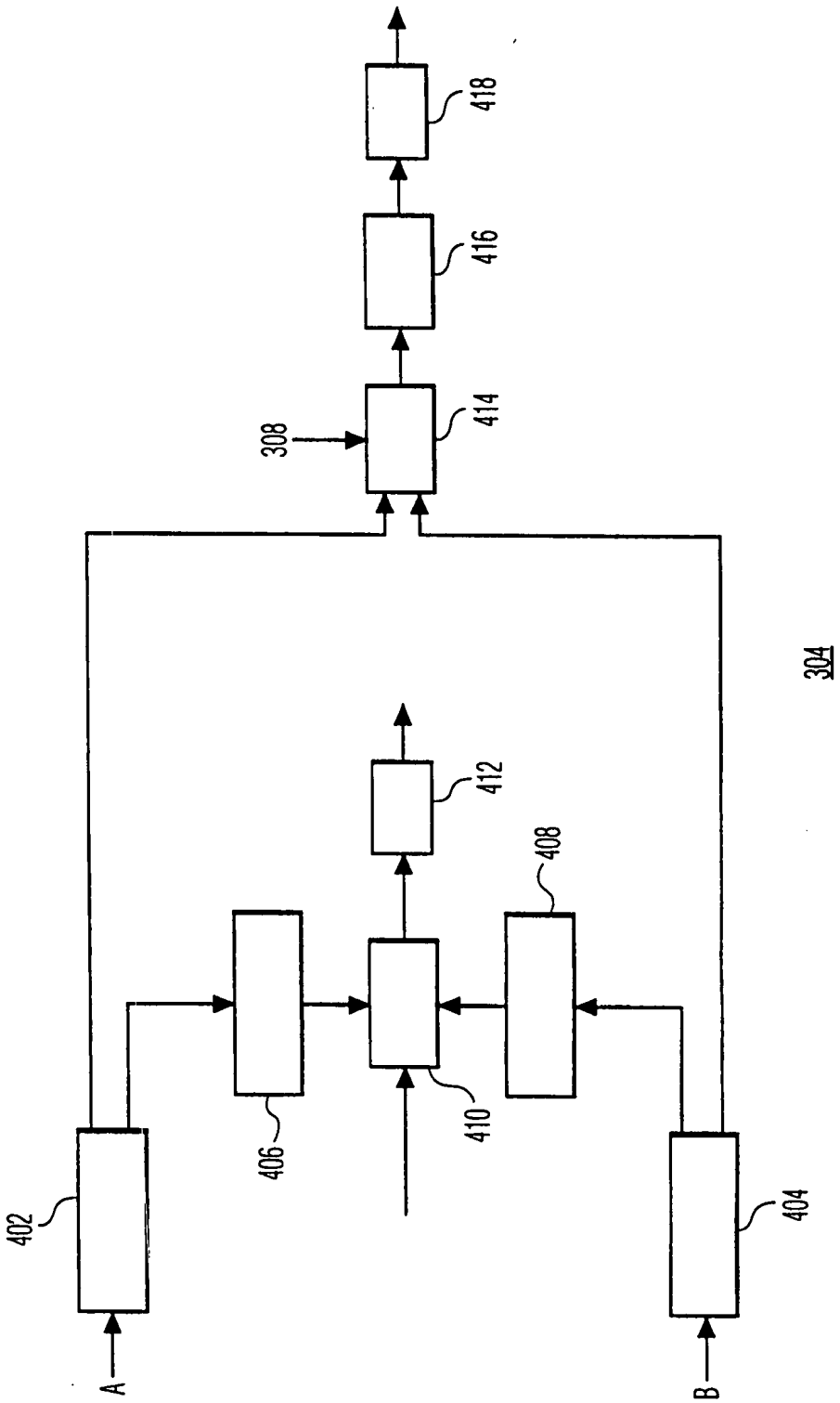


FIG. 4

INTERNATIONAL SEARCH REPORT

Intern. nal Application No
PCT/EP 00/09078

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04N7/173

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 701 582 A (DEBEY HENRY C) 23 December 1997 (1997-12-23) column 5, line 24 -column 18, line 11 figures 2-10	1,2,4,6, 9
A	EP 0 804 028 A (SONY CORP) 29 October 1997 (1997-10-29) page 4, column 9, line 9 -page 13 figures 1-7	1-11
A	EP 0 749 242 A (IBM) 18 December 1996 (1996-12-18) cited in the application page 3, column 3, line 20 -page 6, column 10, line 24 figures 1-4	1-11

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

'A' document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
21 December 2000	08/01/2001

Name and mailing address of the ISA	Authorized officer
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